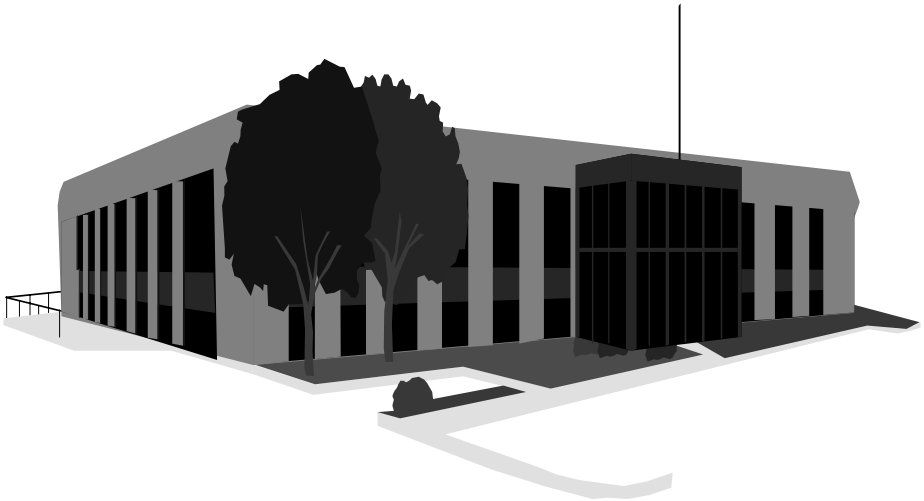
# INDOOR AIR QUALITY ASSESSMENT

**St. John the Evangelist Elementary School**
**111 New Baltch Street**
**Beverly, Massachusetts**



Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
August, 2001

## Background/Introduction

At the request of a parent, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality concerns at St. John the Evangelist Elementary School (SJEES) in Beverly, MA. It is our understanding that concerns were raised by parents whose children were diagnosed with cancer and asked that the MDPH determine the possible relationship with attending school at the SJEES. This assessment was conducted to ascertain whether possible environmental conditions were present within the building that may be related to diagnoses among these children.

On April 26, 2001, a visit was made to this school by Cory Holmes, Environmental Analyst of the Emergency Response/Indoor Air Quality (ER/IAQ) Program, BEHA, and Suzan Donahue, BEHA Research Analyst, to conduct an indoor air quality assessment. BEHA staff were accompanied by April Fellows, a parent and Dick Cussen, an industrial hygienist, for portions of the assessment.

The school is a three-story brick building constructed in 1955. Renovations were done to the third floor in 1998. The school houses pre-kindergarten through eighth grade students. The third floor contains a music room, library, computer room, science room, conference room and offices. The second floor is made up of general classrooms. Located at ground level are general classrooms, teachers' lounge and office space. The lower level contains the nurse's office, cafeteria, kitchen, kiln room and boiler room. The church is a one-story structure attached to the front of, and accessible from, the school.

The cafeteria and several classrooms are reportedly used for bingo after school hours. In order to circulate air and deal with second hand smoke, an air-handling unit

(AHU) and several air cleaners were installed in the cafeteria. However, all bingo games on school premises are now "smoke-free".

## Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551.

## Results

This school has a student population of 295 and a staff of approximately 30. Tests were taken during normal operations at the school. Test results appear in Tables 1-6.

## Discussion

### Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million of air (ppm) in twenty-one out of thirty-one areas surveyed, indicating an overall ventilation problem in the school. It is important to note that all classrooms with carbon dioxide levels below 800 ppm had open windows during the assessment or were sparsely populated, which can greatly contribute to reduced carbon dioxide levels. The MDPH approach to resolving indoor air quality problems is primarily two-fold, 1) improving ventilation to dilute and remove environmental pollutants and 2) reduce or eliminate exposure from materials that may be adversely affecting indoor air quality.

Fresh air in classrooms is supplied by a unit ventilator (univent) system (see Pictures 1 & 2). Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building (see Picture 3) and return air through an air intake located at the base of each unit (see Figure 1). Fresh and return air are mixed, filtered, heated and provided to classrooms through a fresh air diffuser located in the top of the unit. Univents were found turned off in classrooms throughout the school. Obstructions to airflow, such as papers and books stored on univents and bookcases and carts and desks in front of univent returns were seen in a number of classrooms (see Picture 2). In order for univents to provide fresh air as designed, intakes must remain free of obstructions. Importantly these units must remain "on" and allowed to operate while these rooms are occupied.

Mechanical exhaust ventilation for rooms in the renovated sections of the building (e.g., music room, library) is provided by wall-mounted local exhaust vents controlled by a manual variable speed dial (see Pictures 4 & 5). Mechanical exhaust ventilation for the remainder of the classrooms in the building is provided by wall-mounted intake grills located in coat closets (see Picture 6) powered by rooftop motors (see Picture 7). A number of exhaust vents in both the original and renovated sections of the building were deactivated. BEHA staff examined exhaust motors on the roof and found a number of exhaust motors not operating. Exhaust motors and casings appeared to be original equipment (approximately 40-50 years old) and were corroded, weathered and/or physically damaged (see Pictures 8 & 9). Exhaust vents in the original building have internal flues that are controlled by pull chains to adjust airflow. A few of these vents

had pull chains missing. As with the univents, a number of exhaust vents were obstructed by various items stored in the coat closets.

Ventilation for the cafeteria is provided by a ceiling-mounted air-handling unit (AHU) (see Picture 10). Fresh air is introduced into the unit through an air intake on the exterior of the building and distributed into the cafeteria via air diffusers connected to ductwork. Like many of the univents, the AHU was not operating during the assessment.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing of these systems was not available at the time of the assessment. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997, BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being

exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature readings measured ranged from 63$^{o}$ F to 75$^{o}$ F, which were below the BEHA comfort range in some areas. The BEHA recommends that indoor air temperatures be maintained in a range of 70$^{o}$ F to 78$^{o}$ F in order to provide for the comfort of building occupants. It is difficult to control temperature and maintain comfort without operating the HVAC equipment as designed. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity in the building was below the BEHA recommended comfort range in all areas sampled. Relative humidity measurements ranged from 21 to 34 percent. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. The sensation of dryness and irritation is common in a low

relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

**Microbial/Moisture Concerns**

A few areas had water-damaged ceiling tiles which can indicate leaks from either the roof or plumbing system (see Pictures 11 & 12). An active leak was reported in the church, which resulted from a recent period of heavy precipitation. School officials reported that they have been working with a roofing contractor to try to isolate and repair the leak. Water-damaged ceiling tiles and other porous building materials can provide a source of microbial growth and should be repaired/replaced after a water leak is discovered.

Plants were seen growing in fissures in the rubber membrane roof outside of the library (see Picture 13). Plants can cause damage to building materials by inserting tendrils into these cracks and fissures. As water penetrates along the tendrils, subsequent freezing and thawing during the winter can create further damage.
These breaches of the building envelope can serve as a source of water entry into the building, causing water damage and potentially leading to microbial growth.

Several classrooms contained a number of plants. Plant soil and drip pans can serve as a source of mold growth. Plants should also be located away from univents and exhaust ventilation to prevent aerosolization of dirt, pollen or mold.

**Other Concerns**

Several conditions that can potentially affect indoor air quality were also identified. During the assessment boiler room doors were found open (see Picture 14) and school staff were observed using the boiler room as a pathway from the rear of the building to the cafeteria. Leaving these doors open can serve as a means of egress for heat, particles and fuel odors from the boiler room into adjacent areas (e.g., the cafeteria).

Accumulated chalk dust was noted in several classrooms (see Picture 15). Chalk dust is a fine particulate, which can be easily aerosolized and is an eye and respiratory irritant. Several classrooms contained dry erase boards and dry erase markers. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs), (e.g., methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999), which can be irritating to the eyes, nose and throat.

BEHA staff examined the cafeteria AHU and found the filter coated with dirt/dust and accumulated material (see Picture 16). A debris-saturated filter can obstruct airflow, damage equipment and may serve as a reservoir of particulates that can be re-aerosolized and distributed throughout the cafeteria via the ventilation system. Several areas contained window-mounted air conditioners. These units are also equipped with filters, which should be cleaned or changed as per the manufacturer's instructions to avoid the build up and re-aerosolization of dirt, dust and particulate matter.

Cleaning products were found on countertops and underneath sinks in a number of classrooms. Storage room C2 contained a number of supplies including hydrochloric acid and a number of flammable materials (see Pictures 17 & 18). This area was found open during the assessment, allowing easy student access. Cleaning products and

flammables contain chemicals, which can be irritating to the eyes, nose and throat. These materials should be stored properly and kept out of reach of students.

### Cancer Concerns

From the initial information provided by parents, three of the four cancers reported were of the same primary site, however it is not clear if the cases were histologically similar. Many people do not realize that cancer is not a singular disease, but rather is representative of a diverse group of diseases. Cancer is classifiable by primary site (original location in the body) and histology (or cell type). Epidemiological studies have shown that different types of cancer are actually different diseases with separate causes, risks, characteristics, and patterns of survival. Thus, reports of several different types of cancers not suggestive of any single risk factor (e.g., an environmental exposure).

Air monitoring and observation of indoor environmental conditions by BEHA staff did not identify any obvious conditions that would increase the risk of developing cancer among building occupants. While conditions in the building do not suggest that environmental factors at the SJEES are likely to have played a role, access to personal medical information would be required in order for MDPH to further evaluate cancer concerns. Informed consent forms were provided to facilitate this follow up activity.

## Conclusions/Recommendations

In view of the findings at the time of the visit, the following recommendations are made:

1. To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy independent of classroom thermostat control.
2. Examine each univent for function. Survey classrooms for univent function to ascertain if an adequate air supply exists for each room. Consider consulting a heating, ventilation and air conditioning (HVAC) engineer concerning the calibration of univent fresh air control dampers school-wide.
3. Restore exhaust ventilation in classrooms and restrooms. Inspect exhaust motors and belts for proper function, repair and replace as necessary. Ensure flues are open and pull chains for closet exhaust vents in the old wing are operable.
4. Remove all blockages from univents and exhaust vents.
5. Once both the fresh air supply and exhaust ventilation are functioning, the ventilation system should be balanced.
6. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
7. Continue to work with roofing contractor to identify and repair leaks. Replace/repair any remaining water-stained ceiling tiles and building materials. Examine the area above and around these areas for microbial growth. Disinfect areas of water leaks with an appropriate antimicrobial.

8. Move plants away from univents in classrooms. Examine drip pans for mold growth and disinfect areas of water leaks with an appropriate antimicrobial where necessary.
9. Store cleaning products properly and out of reach of students. Store flammables in a flameproof cabinet. Keep custodial/supply rooms locked at all times.
10. Consider installing local exhaust ventilation for kiln. If not feasible, conduct kiln operation after school hours and/or close door to pottery kiln room during ceramic firings. Do not allow students access to this area until firing is complete.
11. Clean chalkboards and trays regularly to avoid the build-up of excessive chalk dust.
12. Keep boiler room doors closed and prevent access to building occupants.
13. Change/clean filters in the cafeteria AHU, univents and wall-mounted air conditioners as per the manufacturer's instructions (or more frequently if needed) to prevent the re-aerosolization of dirt, dust and particulate matter.
14. If signed medical consent forms are provided to the MDPH, an environmental physician will further evaluate cancer concerns.

## References

BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials and Code Administrators International, Inc. Country Club Hill, IL. Section M-308.1.1.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

Sanford. 1999. Material Safety Data Sheet (MSDS No: 198-17). Expo® Dry Erase Markers Bullet, Chisel, and Ultra Fine Tip. Sanford Corporation. Bellwood, IL.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

**Picture 1**

**Classroom Univent in Renovated Portion of Building**

**Picture 2**

**Classroom Univent in Original Portion of Building**

**Picture 3**

**Univent Outside Air Intake**

**Picture 4**

**Wall-Mounted Local Exhaust Vent with Variable Speed Control**

**Picture 5**


**Close-up of Variable Speed Control for Local Exhaust Vent (see Preceding Picture)**

**Picture 6**


**Classroom Exhaust Vent in Coat Closet**

**Picture 7**

**Rooftop Exhaust Motor**

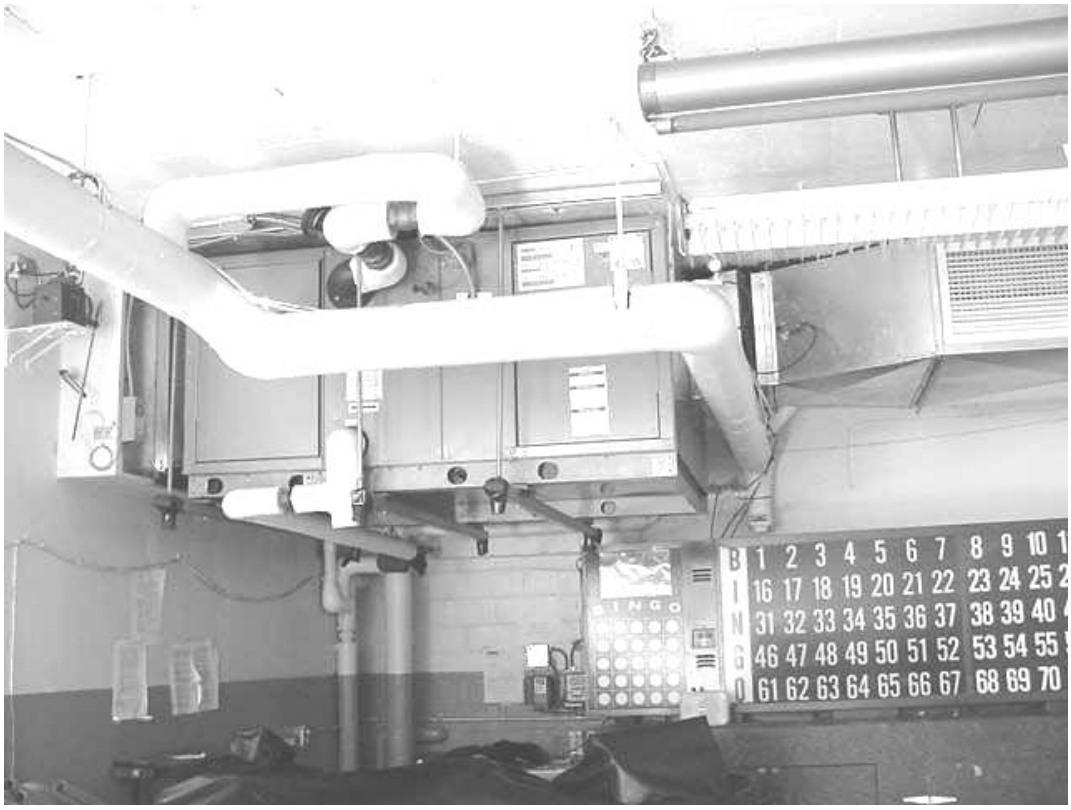
**Picture 8**

**Interior of Exhaust Motor Note Corrosion as Indicated by Rust and Accumulations of Metal Chips and Debris**

**Picture 9**

**Close-up of Dry/Cracked Fan Belt of Rooftop Exhaust Motor**

**Picture 10**




**Ceiling-Mounted AHU in Cafeteria**

**Picture 11**


**Water Damaged Ceiling Tiles**

**Picture 12**

**Water Damaged Ceiling Plaster in Church**

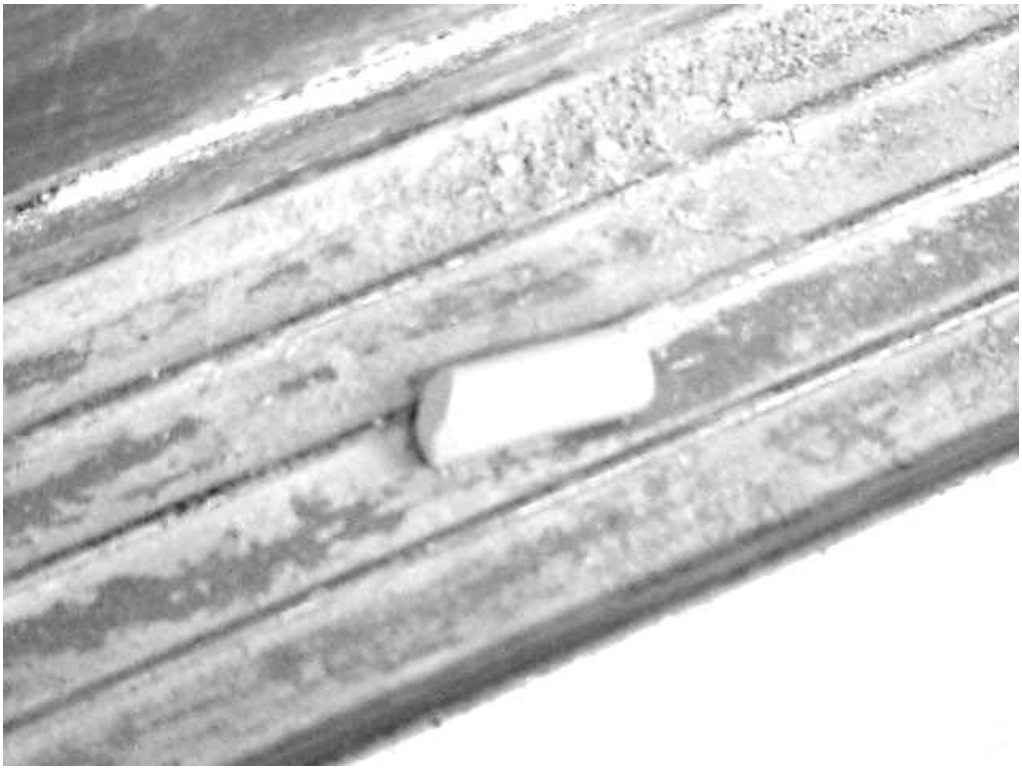
**Picture 13**

**Plant Growth in Cracks of Rubber Membrane Roof**

**Picture 14**

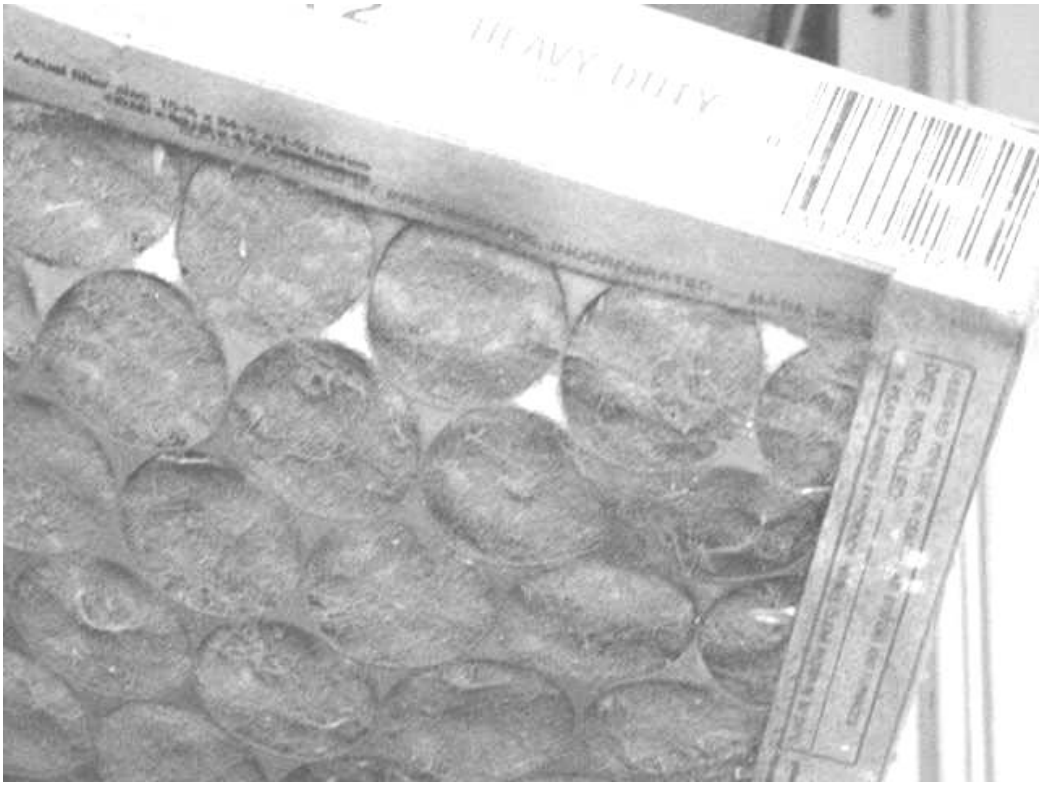

**Opened Boiler Room Door**

**Picture 15**



**Accumulated Chalk Dust in Classroom**

**Picture 16**



**Cafeteria AHU Saturated With Dirt, Dust & Debris**

**Picture 17**

**Open Storeroom/Janitorial Closet**

**Picture 18**


**Cleaning Supplies & Chemicals Found in Open Storeroom**

**TABLE 1**

## Indoor Air Test Results – St. John's Elementary School, Beverly, MA – April 26, 2001

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Intake | Exhaust | |
| Outside (Background) | 430 | 53 | 33 | | | | | Weather conditions: cool, partly cloudy |
| Music Room | 1187 | 67 | 34 | 7 | Yes | Yes | Yes | Wall-mounted exhaust fan, carpet, dry erase board |
| Science Room | 660 | 68 | 27 | 0 | Yes | Yes (2) | Yes | Wall mounted exhaust fan, water damaged ceiling plaster, chalk dust |
| Library | 1205 | 70 | 30 | 1 | Yes | Yes | Yes | Wall mounted exhaust fan-inoperable, univent off, carpet |
| Music Director's Office | 1399 | 71 | 31 | 1 | Yes | No | No | Hole in wall (clock removed), area rug, door open |
| Mrs. Hoar's Office | 1639 | 71 | 32 | 0 | Yes | No | No | Carpet, dry erase board |
| Computer Room | 1294 | 73 | 29 | 3 | Yes | Yes (2) | Yes | Wall mounted exhaust fan-inoperable, 1 out of 2 univents off, carpet, personal fan, dry erase board, window and door open |
| 3rd Floor Conference Room | 1373 | 72 | 29 | 2 | Yes | No | No | Carpet, flowers in vases, door open, dry erase board |
| Custodial Closet | | | | | No | Yes | Yes | Passive supply vent in door, exhaust off |
| 3rd Floor, Girl's Restroom | | | | | Yes | Yes | Yes | Window open, passive supply vent in door, exhaust off |

*** ppm = parts per million parts of air**
**CT = ceiling tiles**

**Comfort Guidelines**

| | |
|---|---|
| Carbon Dioxide - | < 600 ppm = preferred |
| | 600 - 800 ppm = acceptable |
| | > 800 ppm = indicative of ventilation problems |
| Temperature - | 70 - 78 °F |
| Relative Humidity - | 40 - 60% |

**TABLE 2**

## Indoor Air Test Results – St. John's Elementary School, Beverly, MA – April 26, 2001

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Intake | Exhaust | |
| 3rd Floor, Boy's Restroom | | | | | Yes | Yes | Yes | Passive supply vent in door, exhaust off |
| Mr. Pirainos' Office | 1569 | 73 | 30 | 0 | Yes | No | No | Carpet, sink-spray cleaners, utility holes, door open |
| 2nd Floor Ladies' Restroom | | | | | Yes | Yes | Yes | Passive supply vent in door, exhaust off, window slightly open |
| Grade 3 | 1708 | 74 | 30 | 28 | Yes | Yes | Yes | *Classroom exhaust vent located in upper left hand corner of closet-missing grille-gravity pull chain |
| Grade 4 | 1922 | 75 | 31 | 28 | Yes | Yes | Yes | Exhaust off-materials stored inside vent-undercut door obstructed, plantings/soil on univent, broken window, chalk dust |
| C2 Storage | | | | | | | No | Door open, cleaning/maintenance supplies-flammables-turpentine, hydrochloric acid, propane cylinder, WD-40, grinding wheel |
| B1 Pre-Kindergarten | 679 | 73 | 21 | 0 | Yes | Yes | Yes | Window open, wall mounted exhaust vent off, partial carpet, spray cleaners, frog "pond", eggs/incubator, aquarium, plantings on univent, dry erase |

*** ppm = parts per million parts of air**
**CT = ceiling tiles**

**Comfort Guidelines**

| | |
|---|---|
| Carbon Dioxide - | < 600 ppm = preferred |
| | 600 - 800 ppm = acceptable |
| | > 800 ppm = indicative of ventilation problems |
| Temperature - | 70 - 78 °F |
| Relative Humidity - | 40 - 60% |

**TABLE 3**

## Indoor Air Test Results – St. John's Elementary School, Beverly, MA – April 26, 2001

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Intake | Exhaust | |
| | | | | | | | | board |
| Cafeteria | 996 | 71 | 27 | ~30 | Yes | Yes | Yes | Ceiling mounted AHU-off-filters dirty, exhaust off, 4 window mounted A/C-1 covered-1 missing front grille, boiler room door open |
| Kitchen | 1078 | 72 | 28 | 5 | Yes | | Yes | Exhaust off, un-vented old gas stove, cleaners, personal fan, 2 refrigerators |
| Nurse's Office | 753 | 69 | 26 | 0 | Yes | No | No | Utility holes, 2 plants |
| Development Office | 759 | 69 | 27 | 0 | Yes | No | No | |
| Sister Agnes' Conference Room | 540 | 69 | 21 | 1 | Yes | No | No | Windows open, area rug, sink, window mounted A/C, 4 plants, refrigerator |
| Sister Agnes' Office | 498 | 67 | 21 | 0 | Yes | No | No | Window open, plant, carpet, humidifier |
| Kiln Room | | | | | Yes | | No | |
| Art Room | 675 | 71 | 22 | 0 | Yes | Yes | Yes | Dry erase board |

*** ppm = parts per million parts of air**
**CT = ceiling tiles**

**Comfort Guidelines**

| | |
|---|---|
| Carbon Dioxide - | < 600 ppm = preferred |
| | 600 - 800 ppm = acceptable |
| | > 800 ppm = indicative of ventilation problems |
| Temperature - | 70 - 78 °F |
| Relative Humidity - | 40 - 60% |

**TABLE 4**

## Indoor Air Test Results – St. John's Elementary School, Beverly, MA – April 26, 2001

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Intake | Exhaust | |
| Teachers' Lounge | 663 | 71 | 22 | 2 | Yes | No | | Window open, restroom-exhaust off-(light switch activated), abandoned exhaust hood, lamination machine, water damaged ceiling plaster, drafts coming from hole in floor, refrigerator, 3 plants |
| 2nd Floor - Copy Room | | | | | No | No | No | Photocopier, activation switch for "3rd flr toilets" |
| 2nd Floor - Custodian Room | | | | | No | No | No | Bucket of water with mop |
| Storage Room | | | | | No | No | No | |
| Grade 2 | 1369 | 73 | 29 | 3 | Yes | Yes | Yes | 30 occupants gone ~2 hrs, exhaust off, chalk dust |
| 2nd Floor – Boy's Restroom | | | | | Yes | Yes | Yes | Passive supply vent in door, exhaust off |
| Grade 1 | 2152 | 73 | 34 | 31 | Yes | Yes | | Window open, supply off, personal fan, 2 plants |
| Kindergarten | 1125 | 71 | 27 | 8 | Yes | No | No | Window open, carpet, 10+ plants, exterior door, window mounted A/C, aquarium with leaves/water- |

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**CT = ceiling tiles**

**Comfort Guidelines**

| | |
|---|---|
| Carbon Dioxide - | < 600 ppm = preferred |
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| | > 800 ppm = indicative of ventilation problems |
| Temperature - | 70 - 78 °F |
| Relative Humidity - | 40 - 60% |

**TABLE 5**

## Indoor Air Test Results – St. John's Elementary School, Beverly, MA – April 26, 2001

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Intake | Exhaust | |
| | | | | | | | | "soil decomposers" |
| Kindergarten Office | 1105 | 72 | 27 | 5 | Yes | No | No | Carpet, door open |
| Kindergarten Restroom | | | | | Yes | | No | Spray cleaners on windowsill |
| B1 Office | 822 | 71 | 26 | 0 | Yes | No | No | Carpet, photocopier, sink, restroom-exhaust activated by light switch |
| Principal's Office | 1132 | 72 | 28 | 3 | Yes | No | No | Carpet, restroom-no exhaust |
| Storage/Copy Room | | | | | No | No | No | Photocopier, risograph |
| Grade 8 | 1027 | 72 | 23 | 19 | Yes | Yes | Yes | Window open, window mounted A/C, chalk dust, *bingo room |
| Grade 7 | 1497 | 72 | 26 | 28 | Yes | Yes | Yes | Univent off, door open, chalk dust, *bingo room |
| 1st Floor Ladies/Girl's Restroom | | | | | Yes | Yes | Yes | Passive supply vent in door, exhaust weak/off, wall mounted air fresheners |
| School Store | | | | | No | | No | Door undercut |

*** ppm = parts per million parts of air**
**CT = ceiling tiles**

**Comfort Guidelines**

| | |
|---|---|
| Carbon Dioxide - | < 600 ppm = preferred |
| | 600 - 800 ppm = acceptable |
| | > 800 ppm = indicative of ventilation problems |
| Temperature - | 70 - 78 °F |
| Relative Humidity - | 40 - 60% |

**TABLE 6**

## Indoor Air Test Results – St. John's Elementary School, Beverly, MA – April 26, 2001

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Intake | Exhaust | |
| Grade 6 | 1004 | 72 | 24 | 30 | Yes | Yes | Yes | Windows wide open, chalk dust, dry erase board, 2 window mounted A/C, *bingo room |
| Grade 5 | 802 | 72 | 23 | 27 | Yes | Yes | Yes | Windows open, chalk dust, 2 window mounted A/C, univent covered, plants, *bingo room |
| Church | 670 | 65 | 28 | 0 | Yes | Yes (13) | Yes (4) | Ceiling fans, carpet on wood floors, plants-no drip pans-on carpet |
| Church – Back Room | | | | 0 | Yes | Yes | No | |
| Church – Front Room | 557 | 63 | 30 | 0 | Yes | No | No | Carpet, ~18 water damaged CT |

*** ppm = parts per million parts of air**
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**Comfort Guidelines**

| | |
|---|---|
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